

REVISION OF THE AUSTRALIAN  
TERTIARY VOLUTIDAE  
(MOLLUSCA: GASTEROPODA).  
1. THE SUBFAMILY ATHLETINAE

THOMAS A. DARRAGH

*Curator of Fossils,*

*National Museum of Victoria, Melbourne.*

Plates 14-16

ABSTRACT

The genus *Athleta* Conrad 1853 is briefly discussed and the following are regarded as synonyms; *Volutocorbis* Dall 1890, *Volutopupa* Dall 1890, *Neoathleta* Bellardi 1890, *Volutospina* Newton 1906, *Notoplejona* Marwick 1926, *Coathleta* Gardner 1945, *Volutovetus* Pilsbry and Olsson 1954 and *Bendeluta* Eames 1957. *Ternivoluta* Martens 1897 is regarded as a subgenus of *Athleta*, and *Austrovoluta* Cotton 1949 is shown to be a synonym of the former. *Ternivoluta* is restricted to Australia and ranges from Upper Eocene to Recent. A lineage in the subgenus from Upper Eocene to Upper Miocene is reported. *A. (Athleta) wangerrip* (Upper Paleocene), *A. (Ternivoluta) curvicostata* (Upper Eocene), *A. (T.) anticingulata craticula* (Lower Miocene), *A. (T.) subcrenulifera* (Lower Miocene) and *A. (T.) bungae* are newly described from Victoria, Australia and five other species and subspecies are redescribed.

INTRODUCTION

The sub-family Athletinae is represented in Australia by *Athleta* s.s. and the subgenus *Ternivoluta*. *Athleta* ss. is widespread throughout Europe, Asia and America particularly in the Paleogene, but in Australia it is represented by a single species in the Upper Paleocene of Victoria. It is probable that this species gave rise to the earliest known species of *Ternivoluta* present in the Upper Eocene.

The subgenus *Ternivoluta*, one of two living representatives of the ancient volutid sub-family Athletinae, occurs commonly in the Tertiary of South-eastern Australia and has not been recorded elsewhere. The initial appearance is in the Upper Eocene and from the Upper Eocene to Upper Miocene there is a single complete lineage with two minor offshoots. Finally there is a single living representative in the deeper waters of the continental shelf off Southern Queensland and Northern New South Wales.

*Ternivoluta*, established originally by Martens in 1897 as a subgenus of *Voluta*, has as its type species *Voluta (Ternivoluta) studeri* Martens 1897 based on a unique specimen collected by the "Gazelle" from Eastern Australia in 1875. The radula of this specimen had previously been described by Schacko in 1881 as that of *Voluta concinna* Broderip and due to its resemblance to that of *Volutocorbis abyssicola* (Adams and Reeve) Theile, in 1929, placed *Ternivoluta* as a sub-genus of *Volutocorbis* Dall 1890. There the matter rested until 1959 when McMichael reported the rediscovery of the type species in the neighbourhood of Tin Can Bay, Queensland, redescribed the shell and outlined the previous history of the genus and species. A year later McMichael (1960) briefly described the

animal, refigured the radula and reported the occurrence of numerous specimens from off Cape Byron, N.S.W. Further specimens of *Ternivoluta studeri* have become available in recent years due to the activities of Queensland prawn trawlers.

An examination of actual specimens of this species has shown that a close relationship exists between it and fossils from the Tertiary of Southeastern Australia hitherto placed in the genus *Austrovoluta* Cotton 1949. This genus was erected for a group of species superficially resembling members of *Volutospina* (= *Athleta*) in overall shell morphology but having, inter alia, a paucispiral deviated protoconch unlike the multi-spiral turbinate protoconch of species of *Athleta*. The difference in protoconch was pointed out when McCoy first described the Australian fossil species in 1866 and for this reason he preferred to place his species in *Voluta* rather than *Volutilithes* (= *Athleta*). However Harris in 1897 placed the Australian fossils in *Volutilithes* and queried, on the evidence of the protoconchs, whether they should be placed in a new subgenus. Finally in 1949 Cotton erected *Austrovoluta* for these species but this present study shows that the living and fossil species, having similar protoconchs, are consubgeneric, therefore *Austrovoluta* falls into the synonymy of *Ternivoluta*.

#### RELATIONSHIPS WITHIN THE SUBFAMILY

The relationship of *Ternivoluta* to other members of the subfamily needs clarification but this cannot be done until the status of the other taxa has been re-assessed. At least nine names have been proposed for taxa in the *Athleta* complex but currently only *Athleta*, *Volutocorbis*, *Neoathleta* and *Volutospina* have received widespread acceptance following the classification proposed by Cossmann (1899, p. 99) which was slightly modified by Wenz (1943, p. 1317). It has not been possible to revise this group at this stage because of the large number of species involved and because of their wide and complex geographical and stratigraphical distribution. However some comments are worth presenting as a preliminary to such a revision.

Firstly it should be pointed out that most authors have overlooked or ignored Cossmann's re-assessment of his 1899 classification of these volutes (Cossmann 1906, p. 222, 1909, p. 209). He proposed that *Volutocorbis*, *Volutospina* (= *Volutilithes* auct.) and *Neoathleta* should be placed in the synonymy of *Athleta*. Essentially his reasons for this were that the grounds of separation were slight, mostly differences in sculpture, and that some species could equally well be placed in any one or other of the taxa. He further stated that some species in the Anglo-Paris Basin showed a gradation from one sculptural type to another and that Burnett Smith (1906) had shown that there was a gradual transition with time through various stages similar to the European forms in the Eocene species of the United States.

Recently Fischer, Rodda and Dietrich (1964) re-examined the American species and generally supported Smith's conclusions that the Eocene species of the south-eastern United States were derived from a Paleocene cancellate ancestor (*Volutocorbis limopsis*) and showed that a great variety of shape and sculptural diversity was possible within a single lineage or closely related lineages. They advocated the use of *Athleta* for the Eocene species and used *Volutocorbis* for the Paleocene cancellate species.

## Athletinae

Examination of European Eocene volutes shows that they too probably have a cancellate ancestor but, unlike the American situation, both cancellate and non-cancellate species are present in the same beds in the Paleocene at Mons and in the stages of the Eocene of the Anglo-Paris Basin. There is every sculptural gradation between the two as already pointed out by Cossmann.

The author, therefore, takes the view of Cossmann that *Athleta* only should be used for the entire suite of volutes, at least until further phylogenetic studies are undertaken, particularly on the European and Pakistani volutes which have an important bearing on the problem. As Fischer, Rodda and Dietrich have stated (1964, p. 6) the multispiral protoconch of *Athleta* probably indicates a long pelagic larval stage, so that there is a possibility of wide and rapid dispersal which could explain the wide geographical distribution of this group of volutes in the Tertiary.

The various taxa which have been proposed in this complex of volutes are listed below and more detailed reasons given for the author's rejection of these names.

*Athleta* Conrad 1853. Type species (SD Dall, 1890) *Voluta rarispina* Lamarck 1811, Miocene, France.

This is the oldest valid name for this group of volutes. Unfortunately the type species is not typical of the group as a whole because of the prominent development of parietal callus, the thickening of the outer lip to produce a cassid-like aperture and the modification of the sculpture of the final whorl. These features have arisen independently in other species several times throughout the geological history of the group and in different lineages, so that there seems little justification for regarding such features as of generic or sub-generic importance. Some of the species which demonstrate the features alluded to are *A. labrella* (Lamarck), Upper Eocene, France; *A. cingulata* (Nyst), Lower Oligocene, Germany; *A. rathieri* (Hebért), Oligocene, Belgium and Germany; *A. affinis* (Brocchi) Miocene, Italy; *A. tuomeyi* Conrad, Lower Eocene, U.S.A. and *A. necopinata* Suter, Middle Eocene, New Zealand.

*Volutocorbis* Dall 1890. Type species (OD Dall, 1890) *Volutilithes limopsis* Conrad 1860, Paleocene, U.S.A.

The distinguishing features of this genus were the cancellate sculpture, the weaker anterior notch and the lack of spines on the shoulder. Currently the following European Eocene species are placed in the genus; *V. digitilina* (Lamarck), *V. lima* (Sowerby) and *V. crenulifera* (Bayan). However there is a gradation in morphology between the first two and *V. crenulifera*, and from the latter to the Eocene *Voluta bicorona* Lamarck and *V. elevata* Sowerby, both of which have been regarded as species of *Volutospina*. Both *bicorona* and *elevata* could equally well be regarded as species of *Volutocorbis* because of their cancellate sculpture and lack of a prominent shoulder. This gradation towards a *Volutospina*-like form suggests that *Volutocorbis* should be dropped in favour of *Athleta* as *Volutospina* is regarded as a synonym of this latter genus.

Rehder (1969) has illustrated the six known living species assigned to *Volutocorbis*, and they are somewhat variable in morphology; some species match *V. digitilina* (Lamarck) and *V. limopsis* (Conrad) but two living species, *V. boswellae* Rehder and *V. disparilis* Rehder are not unlike

the ribbed form of the Miocene *Athleta suturalis* (Nyst) (= *cingulata* Nyst) with little or no cancellate sculpture and a small shoulder. He states (1969, p. 201) that there are no known species of *Volutocorbis* connecting the Eocene and Recent species. In view of the similarity of some of the living species to *Athleta suturalis*, and if as the author believes, the "*Volutocorbis*" appearance can arise independently, the living species could have developed from Oligocene or Miocene species and the gap in the fossil record is greatly reduced.

With regard to the Australian *Ternivoluta* lineage it should be stressed that there are all forms of sculpture from highly cancellate to smooth, and all types of shoulder form from small with no spines to large with prominent spines, yet all are in the one lineage.

In summary then it seems that whilst cancellate species with sutural grooves rather than prominent shoulders are typical of the early Tertiary and Upper Cretaceous there seems little point in differentiating these, at least until proper phylogenetic studies are made and the significance or otherwise of such features determined.

*Neoathleta* Bellardi 1890. Type species (OD) *Voluta affinis* Brocchi 1814, Lower Miocene Italy. Judging from illustrations this species appears to be closely related to *Athleta rathieri* (Hébert) which has been discussed under *Athleta*.

*Volutopupa* Dall 1890. Type species (Monotypy) *Voluta cithara* Lamarck 1803, Middle Eocene, France.

The distinguishing feature of this taxon was the high smooth multi-whorled protoconch, which is not regarded as having any generic significance but merely indicates that the pelagic larval stage was probably longer than in other species of *Athleta*. Fischer, Rodda and Dietrich (1964, p. 5) have shown that the protoconch of this group of volutes can vary within a particular lineage.

*Ternivoluta* Martens 1897. Type species (SD Sykes, Smith and Crick 1898) *Voluta (Ternivoluta) studeri* Martens, Recent Australia.

The only significant differences which this taxon exhibits when compared with *Athleta* are the paucispiral deviated protoconch and the lack of internal ridges or denticles on the inner side of the outer lip. It is felt that as these differences are constant throughout its history, *Ternivoluta* can be regarded as a subgenus of *Athleta* which is confined to the Australian region during the Tertiary. The form of protoconch suggests that there was no planktonic larval stage but rather direct development, which would inhibit the distribution of the subgenus.

*Volutospina* Newton 1906. Type species (OD) *Conus spinosus* Linnaeus 1756, Middle Eocene, France.

The type species is typical of the group as a whole but as indicated above, *Athleta* founded on a rather bizarre member of the group has priority.

*Notoplejona* Marwick 1926. Type species (OD) *Athleta necopinata* Suter 1917, Middle Eocene, New Zealand.

This genus was distinguished by the crenulated and thickened outer lip, by the prominent anterior siphonal notch and fasciole, by the presence

## Athletinae

of one major and several minor plaits which were situated on a callus pad in mature specimens and by the nature of the parietal callus. Most of these features are present in *Athleta rarispina* or on other species of *Athleta* and there seems to be no grounds for maintaining the New Zealand species in a separate genus or even subgenus. Certainly it is no more bizarre than the type species of *Athleta*, or *A. tuomeyi* Conrad and *A. labrella* (Lamarck).

*Eoathleta* Gardner 1945. The species (OD) *Athleta tuomeyi* Conrad 1853, Lower Eocene, U.S.A.

The reasons for regarding this taxon as a synonym of *Athleta* have been discussed above.

*Volutovetus* Pilsbury and Olsson 1954. Type species (OD) *Voluta petrosa* Conrad 1833, Middle Eocene, U.S.A.

The features distinguishing this taxon from its European relatives were the stronger columella plaits but as the strength of the columella plaits varies from individual to individual within a species there are no grounds for using this feature as a generic distinction. In all features the type species bears a considerable resemblance to the European Eocene species of *Athleta*.

*Bendeluta* Eames 1957. Type species (OD) *Volutospina conicoturrita* Newton 1922, Upper Eocene, Nigeria.

This taxon was differentiated from *Volutospina* by sculptural and apertural differences which seem minor in view of the great variation found, for example, in the Paris Basin species of *Athleta* (= *Volutospina*). Moreover the type species bears a considerable resemblance to the New Zealand *Athleta necopinata* Suter so that *Bendeluta* would be a synonym of *Notoplejona*, should the latter ultimately be accepted.

The other members of the subfamily are *Volutocristata* Gardner and Bowles 1934, *Retipirula* Dall 1907, and possibly one or two other Tertiary genera, as well as certain Cretaceous genera such as *Volutomorpha* Gabb 1877 which has been placed in the subfamily Volutoderminae Pilsbury and Olsson 1954. In view of the similarity of the genera of this subfamily to those of the Athletinae there seems little need for a subfamily Volutoderminae.

## STRATIGRAPHICAL DISTRIBUTION

The Upper Paleocene *Athleta* (*Athleta*) *wangerrip* sp. nov. is the only known species of the genus in Australia. Its origin is unknown at present but presumably it is derived from a late Cretaceous *Athleta*, such as *A. debeyi* (Binckhorst) from the type Maastrichtian. It seems reasonable to assume that this Paleocene species is the ancestor of the Uppermost Eocene *A. (Ternivoluta) curvicostata* sp. nov. though no intermediate records of the genus are known in the molluscan faunas of the earlier Upper Eocene sediments. *A. (T.) curvicostata* is the species which gives rise to a lineage which is well documented through to the late Miocene.

Members of the lineage are of considerable stratigraphic usefulness particularly in the Otway Basin because of rapid changes in morphology of members of the lineage with time. Broadly speaking the lineage can be divided into two parts; the first, typified by *A. (T.) anticungulata* (Mc-

Coy), having merely a presutural groove and a row of sutural nodules, and without spines or shoulders; and the second, typified by *A. (T.) antiscalaris* (McCoy), with prominent spinose shoulders. The change occurs rather abruptly in the upper part of the Longfordian, late Lower Miocene. Details of morphological changes within these two broad groups and stratigraphical ranges of taxa have been given in the systematic descriptions and need not be repeated here. Figure 1 shows the stratigraphical ranges of the several species and subspecies and illustrates the morphological changes through time.

#### NOTES ON SYSTEMATIC DESCRIPTIONS

All dimensions are in millimetres and a standard set of measurements have been taken as follows: L, total length of specimen; HA, height of aperture measured parallel to the axis of the shell; W, width of final whorl measured between the ribs.

All localities are in Victoria, Australia, unless stated otherwise and have standard grid references taken from the Australian one mile map series.

The species are described in ascending stratigraphical order.

#### SYSTEMATICS

##### SUBFAMILY ATHLETINAE PILSBRY AND OLSSON 1954

##### Genus *Athleta* Conrad 1853

##### Subgenus *Athleta* s.s.

*Athleta* Conrad 1853, *Proc. Acad. Nat. Sci. Philad.*, 6 (12): 448-9.

**TYPE SPECIES:** (Subsequent designation, Dall 1890, p. 75): *Voluta rarispina* Lamarck 1811.

**STRATIGRAPHIC RANGE:** Upper Cretaceous — Recent.

**DISTRIBUTION:** Europe, Asia, Africa (Upper Cretaceous); Cosmopolitan (Paleogene); Europe, Asia (Neogene); South and East Africa (Recent).

**COMMENTS:** Because of the complexity of the taxonomy no formal synonymy is presented. Several synonyms of the genus have been listed in the earlier discussion and need not be repeated. A partial synonymy and a description of this taxon can be found in Fischer, Rodda and Dietrich (1964, p. 38).

##### *Athleta (Athleta) wangerrip* sp. nov.

Pl. 16, fig. 27-28, 31-32; Fig. A.

**DESCRIPTION:** Shell broadly fusiform with a subconical spire and tumid body whorl tapering rapidly to the anterior canal. Protoconch small, turbinata, of about three smooth whorls which merge with the juvenile whorls of the spire, first juvenile spire whorl with oblique narrow axial costae which at the ninth costa or so show signs of a groove which cuts the costae close to the anterior suture, forming a series of spinose nodules against the suture and an anterior set of axial costae which are spinose on the shoulder. The groove broadens on the adult whorls to form the ramp of the posterior portion of the shoulder.

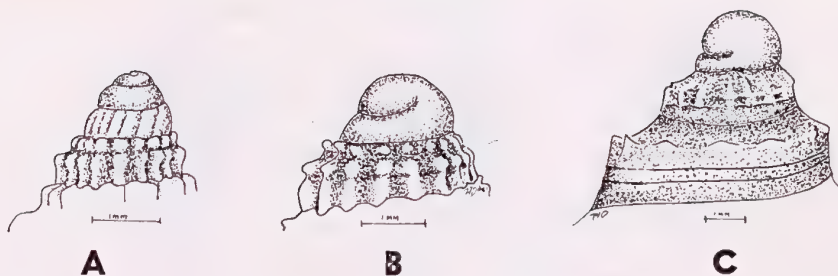


Figure A. *Athleta (A.) wangerrip* sp. nov., P28032. Protoconch of holotype. Compares with that of *A. (A.) rarispina* (Lamarck) figured by Fischer et al. (1964 p. 40).

Figure B. *Athleta (Ternivoluta) antiscalaris antiscalaris* (McCoy), P22486, protoconch of paralectotype. Typical of all the fossil species.

Figure C. *Athleta (Ternivoluta) studeri* (Martens), F27420 protoconch of hypotype, 100 fathoms off Cape Morton, Qld.

Body whorl with about twelve axial costae which extend over about half of the anterior whorl slope and on mature specimens tend to lose their spinose character at the shoulder. Spiral sculpture absent from the spire whorls but fine lirae are present on the anterior slope of the body whorl and are either weakly developed or absent near the shoulder of the whorl. Columella with two major plaits and a thin posterior minor plait.

#### DIMENSIONS:

Holotype	P28032	L25	HA17	W12
Paratype	P22474	26	18	12
Paratype	P22475		18	11 spire incomplete

**LOCATION OF TYPES:** National Museum of Victoria. Holotype P28032, collected T. A. Darragh 19 Nov. 1970; Paratype P22474, J. Dennant Collection; Paratype P22475, G. S. V. Collection, collected C. S. Wilkinson 1865.

**TYPE LOCALITY:** Geological Survey of Victoria locality Aw7, River-nook, black silt beneath an outcrop of indurated siltstone one mile SE. of Point Ronald, Princetown. Grid Ref. Princetown 063250. "Trochocyathus band", Dilwyn Formation, Wangerripian, Upper Paleocene.

**STRATIGRAPHIC RANGE:** Wangerripian, Upper Paleocene.

**OCCURRENCE:** Type locality only.

**MATERIAL:** Holotype, four reasonably complete individuals and many fragments.

**COMMENTS:** This species is the only representative of the subgenus as yet recorded from Australia. It is not uncommon at the type locality but is usually in the form of large fragments of body whorl rather than complete specimens. In overall morphology it can be compared with *A. (A.) bicorona* (Lamarck) and *A. (A.) elevata* (Sowerby) but it lacks the cancellation on the early spire whorls present in these two species. It bears no obvious relationship with any American *Athleta*.

Subgenus *Ternivoluta* Martens 1897

- Voluta* (*Ternivoluta*) Martens 1897, *Arch. Naturgesch.*, 63 (1) (2): 177.  
*Volutocorbis* (*Ternivoluta*) Thiele 1929, *Handbuch der Systematischen Weichtierkunde*, 1 (1): 345.  
 Smith 1942, *A review of the Volutidae*, p. 15.  
 Wenz 1943, *Handbuch der Paläozoologie*, 6 (1) (6): 1319.  
*Ternivoluta* Weaver & du Pont, 1970, *Living Volutes*, p. 13.  
*Austrovoluta* Cotton 1949, *Rec. S. Aust. Mus.*, 9(2): 185. (Type species (original designation):  
*Voluta antiscalaris* McCoy 1866).

**TYPE SPECIES:** (Subsequent Designation, Sykes, Smith and Crick 1898, p. 61): *Voluta* (*Ternivoluta*) *studerii* Martens 1897.

**DESCRIPTION:** Shell fusiform to subfusiform and usually with a gradate spire about one third the length of the shell. Protoconch of one and half smooth whorls, the first globose, deviated at right angles to the axis of the spire, the second half whorl merging rapidly into the juvenile spire whorls. Juvenile spire whorls grooved adjacent to the suture and on the adult whorls the groove frequently develops into an angular shoulder with a cingulum or row of nodules on it adjacent to the suture.

Axial costae usually prominent, with nodules and spines on the shoulder. Spiral lirae present on the anterior portion of the body whorl and frequently entirely covering it and the anterior whorl slope of the spire whorls.

Aperture elongately elliptical with a very shallow anterior siphonal notch and with a few faint denticulations coincident with lirae on the edge of the outer lip. Interior of outer lip smooth. Columella with three or four major and three or four minor plaits which on mature specimens are set on a prominent shelly plate. Siphonal fasciole absent. Parietal callus thin, confined to the ventral portion of the body whorl.

**STRATIGRAPHIC RANGE:** Upper Eocene — Recent.

**DISTRIBUTION:** South-eastern Australia (Upper Eocene — Upper Miocene), Eastern Australia (Recent).

**COMMENTS:** The deviated protoconch and the smooth inner surface of the outer lip of the aperture distinguish this genus from others in the subfamily. McMichael (1959) accepted Smith (1942) as the earliest designation of the type species of the genus overlooking the prior designation of Sykes et al. in the *Zoological Record* for 1897.

Vredenburg (1925, p. 132) has compared certain Pakistani Oligocene and Miocene species of *Athleta* with *A. (Ternivoluta) antiscalaris* (McCoy). The principal similarity appears to be the form of the protoconch but the outer lip of the aperture of the Pakistani species has a denticulate or even ribbed inner surface. Judging from illustrations of these species

## PLATE 14.

- Fig. 1, 3. *Athleta* (*Ternivoluta*) *curvicostata* sp. nov., P22477, paratype, Point Flinders, Vict.  
 Fig. 2, 4. *A. (T.) anticingulata craticula* subsp. nov., P22479, holotype, Jan Juc Beach, Torquay, Vict.  
 Fig. 5, 6. *A. (T.) curvicostata* sp. nov., P22476, holotype, Point Flinders, Vict.  
 Fig. 7. *A. (T.) anticingulata craticula* subsp. nov., P22480, paratype, Jan Juc Beach, Torquay, Vict.  
 Fig. 8. *A. (T.) anticingulata anticingulata* (McCoy), P12156, paralectotype, Ad 22, Bird Rock Cliff, Torquay, Vict.  
 Fig. 9. *Ibid.*, P12161, syntype of variety *indivisa*, Ad 22, Bird Rock Cliff, Torquay, Vict.  
 Fig. 10. *Ibid.*, P12160, syntype of variety *indivisa*, Ad 22, Bird Rock Cliff, Torquay, Vict.  
 Fig. 11, 14. *Ibid.*, P12159, syntype of variety *persulcata*, Ad 21, Bird Rock Cliff, Torquay, Vict.  
 Fig. 12, 13. *Ibid.*, P12157, lectotype, Ad 22, Bird Rock Cliff, Torquay, Vict.





they are derived from Pakistani Eocene *Athleta* and probably have no direct relationship with the Australian species, the deviated protoconch probably having developed independently.

*Athleta (Ternivoluta) curvicostata* sp. nov.

Pl. 14, fig. 1, 3, 5-6.

**DESCRIPTION:** Shell narrowly fusiform with a gradate spire and rounded body whorl gently tapering to the anterior canal. Protoconch large (1.7 mm), of about one and one half whorls merging with the juvenile spire whorls, the first whorl globose, deviated, the second smooth for a quarter of a whorl then for the next quarter bearing axial costae which at the fifth or sixth are cut by the sutural groove. Sutural nodules subspinose set on a prominent sutural cingulum. Axial costae thin, numerous (18-27 on the body whorl), sigmoidal, rounded on the shoulder, and extending anteriorly over about two thirds of the anterior whorl slope of the body whorl. Spiral lirae generally confined to the remaining anterior third of the body whorl. Columella with two or three major plaits and one or two minor.

**DIMENSIONS:**

Holotype	P22476	L39	HA26	W17
Paratype	P22477	46	30	20
Paratype	P22478	34	24	14

**LOCATION OF TYPES:** National Museum of Victoria. Holotype P22476, collected T. A. Darragh and H. E. Wilkinson, 5 Dec. 1968. Paratype P22477, collected C. S. Wilkinson 1865. Paratype P22478, F. A. Cudmore Collection.

**TYPE LOCALITY:** Geological Survey locality Aw1, NW. outcrop, 0.6 miles N. of Point Flinders, Grid Ref. Aire 367098. Glen Aire Clay, Upper? Aldingan, Uppermost Eocene.

**STRATIGRAPHIC RANGE:** Upper Aldingan, Uppermost Eocene.

**OCCURRENCE:** GLEN AIRE CLAY: Type locality; G. S. V. loc. Aw4, Aire coast, 1.1 miles NW of the mouth of the Aire River. Grid Ref. Aire 323 147.

**MATERIAL:** Types and numerous topotypes.

**COMMENTS:** In gross morphology this species bears a striking resemblance to *Volutocorbis boswellae* Rehder. It appears to be related to the Paleocene *Athleta (A.) wangerrip* sp. nov. but the costae are not spinose on the shoulder and are more slender and elongate, also there is no suggestion of a shoulder but merely a deep groove and the protoconch is larger deviated and globose. It is the direct ancestor of *A. (T.) anticingulata anticingulata* (McCoy) which has fewer and shorter costae and a more inflated body whorl.

On a few well preserved specimens there is a suggestion of dark narrow spiral bands which are probably traces of original colour banding.

## Athletinae

*Athleta (Ternivoluta) anticingulata anticingulata* (McCoy, 1866)

Pl. 14, fig 8-14.

- Voluta anticingulata*. McCoy 1866, *Ann. Mag. Nat. Hist. Ser. 3*, 18 (107): 379.  
*Voluta anticingulata* var. *b indivisa* McCoy 1866, *Op. cit.* p. 380.  
*Voluta anticingulata* var. *a perstriata* McCoy 1866, *Op. cit.* p. 380 (lapsus for *persulcata*).  
*Voluta anticingulata*. McCoy 1874, *Prod. Pal. Vict.* 1: 24, pl. 6, fig. 2-4.  
*Voluta anticingulata* var. *b indivisa*. McCoy 1874, *Op. cit.* p. 25.  
*Voluta anticingulata* var. *a persulcata*. McCoy 1874, *Op. cit.* p. 25.  
*Voluta antiscalaris*. Johnston 1888, *Geology of Tasmania*. pl. 30, fig. 5, 5a-b. non McCoy 1866.  
*Voluta anticingulata*. Tate 1889, *Trans. R. Soc. S. Aust.* 11: 133.  
*Voluta anticingulata*. Pritchard 1896, *Proc. R. Soc. Vict.* 8: 92.  
*Voluta anticingulata* var. *indivisa*. Pritchard 1896, *Op. cit.* p. 93.  
*Voluta anticingulata* var. *persulcata*. Pritchard 1896, *Op. cit.* p. 93.  
*Volutulithes anticingulatus*. Harris 1897, *Catalogue of Tertiary Mollusca*. p. 98.  
*Voluta anticingulata*. Pritchard 1913, *Proc. R. Soc. Vict.* 26 (1): 192.  
*Voluta anticingulata* var. *indivisa*. Pritchard 1913, *Op. cit.* p. 193.  
*Voluta anticingulata* var. *persulcata*. Pritchard 1913, *Op. cit.* p. 193.  
*Austrovoluta anticingulata*. Cotton 1949, *Rec. S. Aust. Mus.* 9 (2): 185, pl. 15.

**DESCRIPTION:** Shell broadly fusiform with tumid body whorl tapering abruptly to the anterior canal. Protoconch as in *A. (T.) antiscalaris*. Sutural nodules subspinose when present and the sutural groove is narrow, when absent the sutural groove is broad so that the whorls are shouldered. Axial costae sigmoidal (15 - 19 on the body whorl) extending anteriorly over one third to one half of the body whorl. Spiral lirae generally restricted to the anterior third of the body whorl but occasionally extending over the whole whorl and very rarely present on the spire whorls. Columella with three or four major and occasionally one or two minor plaits.

**DIMENSIONS:**

Lectotype	P12157	L41	HA28	W18	McCoy 1874, pl. 6, fig. 2a.
Paralectotype	P12156	45	32	20	Op. cit. fig. 2, specimen distorted.
Paralectotype	P12158	22	15	10	Op. cit. fig. 3.
	P12160	43	30	18	G. S. V. loc. Ad 22.
	P12161	49	33	21	G. S. V. loc. Ad 22, specimen distorted.
	P12162	49	32	20	G. S. V. loc. Ad 22, specimen broken.
	P12159	42	28	20	Ad 21.

**LOCATION OF TYPES:** National Museum of Victoria. Lectotype P12157, Paralectotypes P12156, P12158. Holotype of variety *persulcata* P12159, syntypes of variety *indivisa* P12160-2. Collected Richard Daintree 1861.

**TYPE LOCALITY:** Geological Survey of Victoria locality Ad 22, Bird Rock Cliffs. This locality is a set of strata from about 17' - 37' below the cap of Bird Rock, Grid Ref. Anglesea 355676. Jan Juc Formation, Janjukian, Upper Oligocene.

**STRATIGRAPHIC RANGE:** Janjukian, Upper Oligocene.

**OCCURRENCE:** JAN JUC FORMATION (Janjukian): Type locality and all Jan Juc strata in Bird Rock Cliffs, Torquay; Bed B100, clay immediately beneath the Point Addis Limestone, SW side of Bells Headland, Grid Ref. Anglesea 356676; left bank, Barwon River 3½ miles S. of Birre-  
 gurra, Grid Ref. Colac 864646. **FREESTONE COVE SANDSTONE** (Janjukian): Lowermost part of cliff section between Fossil Bluff and Table Cape, N. of Wynyard, Tas. **FOSSIL BLUFF SANDSTONE** (Janjukian): Upper part of cliff section between Fossil Bluff and Table Cape.

**MATERIAL:** Types and numerous topotypes.

**COMMENTS:** This is the most variable of the species in the genus. The variation is probably at least partly connected with ecological conditions at the time of deposition. At Torquay the population is dimorphic with very few specimens connecting the *indivisa* form with the typical *anticingulata*, whereas at Table Cape there is every gradation between the two and the *persulcata* form which is quite rare at Torquay is more common, particularly in the upper bed. On the other hand the *indivisa* form is found only in the coarser lower bed, the Freestone Cove Sandstone.

*Athleta (Ternivoluta) anticingulata craticula* subsp. nov.

Pl. 14, fig. 2, 4, 7.

**DESCRIPTION:** Shell broadly fusiform with a tumid bodywhorl tapering abruptly to the anterior canal. Protoconch as in *A. (T.) antiscalaris*. Sutural nodules subspinose, set on a prominent sutural cingulum. Whorls slightly shouldered. Axial costae numerous (about 20-28 on the body whorl), somewhat nodulate on the shoulder, extending anteriorly over half the body whorl. Spiral lirae prominent over the whole of the body whorl and with three lirae present on the spire whorls, subnodulate where they cross the axial costae. Columella with four major and two or three minor plaits.

**DIMENSIONS:**

Holotype	P22479	L44	HA29	W19
Paratype	P22480	45	29	18

**LOCATION OF TYPES:** National Museum of Victoria. Holotype P22479, collected T. A. Darragh and H. E. Wilkinson, 14 Dec. 1968. Paratype P22480, coll. T. A. Darragh 1965.

**TYPE LOCALITY:** Cliff section at SW end of Jan Juc beach about 100 yds. NE of Bird Rock, Torquay. Grid Ref. Anglesea 379706. Puebla Clay, Longfordian, Lower Miocene.

**STRATIGRAPHIC RANGE:** Lower part of Longfordian, Lower Miocene.

**PLATE 15.**

Fig. 15, 16. *A. (T.) antiscalaris levior* (McCoy), P12166, lectotype, Fossil Beach, Mornington, Vict.

Fig. 17, 20. *A. (T.) antiscalaris antiscalaris* (McCoy), P12164, lectotype, Curlewis, Vict.

Fig. 18, 22. *A. (T.) subcrenulifera* sp. nov., P22481, holotype, S. bank of Lake Costin, Hordern Vale, Vict.

Fig. 19. *Ibid.*, P22483, paratype, S. bank of Lake Costin, Hordern Vale, Vict.

Fig. 21, 23. *A. (T.) antiscalaris antiscalaris* (McCoy), P22484, hypotype, Kennedys Creek Cutting, Vict.



15



16



17



18



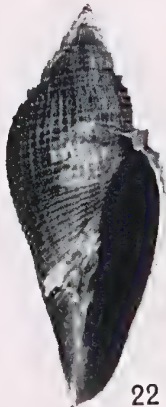
19



20



21



22



23

**OCCURRENCE:** PUEBLA CLAY (Longfordian); Type locality. GELLI-BRAND CLAY (Longfordian); Left bank, Barwon River at Birregurra. **FORMATION UNKNOWN;** 70 feet in a well on J. Keyte's farm, 3 miles E. of Mt. Arapiles.

**MATERIAL:** Types and eight topotypes; twelve specimens from Birregurra.

**COMMENTS:** The presence of spiral lirae over the whole of the spire and body whorl distinguishes this species from *A. (T.) anticingula* s.s., however, as a few individuals of the population of that species in the Jan Juc Formation, the *persulcata* form, approach this subspecies in morphology, it seems proper to treat this taxon as a subspecies of *A. (T.) anticingulata* from which it has evolved by the development of consistent overall spiral ribbing.

This subspecies gives rise to *A. (T.) antiscalaris antiscalaris* (McCoy) and *A. (T.) subcrenulifera* sp. nov. which replace it in the younger horizon of the Longfordian.

*Athleta (Ternivoluta) subcrenulifera* sp. nov.

Pl. 15, fig. 18-19, 22.

**DESCRIPTION:** Shell elongately fusiform with a high gradate spire and rounded gently tapering bodywhorl. Protoconch and early whorls as in *A. (T.) antiscalaris*. Sutural nodules narrow, spinose, set on a prominent sutural cingulum, well separated from the suture itself by a channel which on the adult whorl is as wide as the sutural groove anterior to the cingulum. Axial costae thin, erect and numerous (40-45 on the body whorl), subspinose on the shoulder and extending anteriorly over half the body whorl. Spiral lirae strongly developed over the whole spire and body whorl, weakly nodulate on crossing the axial costae. Columella with two or three major and two or three minor plaits.

**DIMENSIONS:**

Holotype	P22481	L56	HA37	W22
Paratype	P22482	46	30	19
Paratype	P22483	51	32	19

**LOCATION OF TYPES:** National Museum of Victoria. Holotype P22481, Paratype P22482, Paratype P22483 collected T. A. Darragh and K. Bell, 24 Feb. 1970.

**TYPE LOCALITY:** Slip on S. bank of Lake Costin, 0.3 miles W. of Horden Vale-Red Hill Rd., Horden Vale. Grid Ref. Aire 363163. Fishing Point Marl, lower mollusc horizon. Longfordian.

**STRATIGRAPHIC RANGE:** Longfordian, Lower Miocene.

**OCCURRENCE:** FISHING POINT MARL, lower mollusc horizon, (Longfordian): Type locality; Cliff 100 feet above Lake Craven, Aire River, quarter mile NW. of Red Hill, Horden Vale, Grid Ref. Aire 359149.

**MATERIAL:** Types and seven other complete specimens.

**COMMENTS:** The finely cancellate appearance and elongate shape distinguish this species from others in the subgenus. The name alludes

## Athletinae

to its resemblance to *Volutocorbis crenulifera* (Bayan) of the French Eocene. *A. (T.) antiscalaris antiscalaris* (McCoy), its closest ally, is more inflated, has few axial costae and a more prominently shouldered body whorl. They occur together in the lower part of the Fishing Point Marl and both seem to be derived from the early Longfordian *A. (T.) anticin-gulata craticula* sp. nov., however, unlike *A. (T.) antiscalaris* which has a wide distribution, it is restricted to the Aire district and does not give rise to any subsequent species. Why it should have evolved at all is not obvious from the data in hand.

*Athleta (Ternivoluta) antiscalaris antiscalaris* (McCoy, 1866)

Pl. 15, fig. 17, 20 - 21, 23; Pl. 16, fig. 25; Fig. B.

*Voluta antiscalaris*. McCoy 1866, *Ann. Mag. Nat. Hist.* ser. 3, 18 (107): 378.McCoy 1874, *Prod. Pal. Vict.* 1: 26, pl. 6, fig. 5.Tate 1889, *Trans. R. Soc. S. Aust.* 11: 133.*Volutilithes antiscalaris*. Harris 1897, *Catalogue of Tertiary Mollusca* p. 97 partim.*Austrovoluta antiscalaris*. Cotton 1949, *Rec. S. Aust. Mus.* 9 (2): 185, pl. 15.Ludbrook 1961, *Bull. Geol. Surv. S. Aust.* 36, pl. 7, fig. 5.Ludbrook in Parkin 1969, *S. Aust. Geology*. fig. 96-7.

**DESCRIPTION:** Shell broadly fusiform with a tumid body whorl tapering rapidly to the anterior canal. Protoconch of about one and one half whorls which merge imperceptibly with the juvenile spire whorls, first whorl smooth, globose, deviated, the next quarter whorl smooth followed by a quarter whorl bearing sharp axial costae which at the eighth or so are cut by a sutural groove which widens rapidly to form a concave posterior ramp or shoulder on the adult whorls. Sutural nodules spinose and on the body whorl are separated from the suture by a narrow channel. Axial costae sharp, slightly sigmoidal, spinose to subspinose on the shoulder and extending anteriorly over about a third of the body whorl, there are from 16 to 21 on the body whorl. Spiral lirae well developed over the whole spire and body whorl and nodulose where they cross the axial costae. Columella with two or three major and two or three minor plaits.

**DIMENSIONS:**

Lectotype	P12164	L50	HA34	W22	McCoy 1874, pl. 6, fig. 5, 5a.
Paralectotype	P12163	39	25	16	Op. cit. unnumbered figure.
Paralectotype	P22486				Op. cit. unnumbered figure.
Hypotype	P22484	55	36	26	Kennedys Creek cutting.

**LOCATION OF TYPES:** National Museum of Victoria. Lectotype P12164, Paralectotype P12163, Paralectotype P22486, collected R. Daintree G. S. V. April 1861. Hypotype P22484, coll. T. A. Darragh and H. E. Wilkinson 8 Dec. 1968.

**TYPE LOCALITY:** Geological Survey of Victoria locality Ad 14, Section 24, block 1, Parish of Moolap, 1.5 miles N. of Curlewis railway crossing. Grid Ref. Portarlington 578937. Fyansford Clay, Batesfordian.

**STRATIGRAPHIC RANGE:** Upper Longfordian — Batesfordian, Lower Miocene.

**OCCURRENCE:** (Batesfordian.) **FYANSFORD CLAY:** Type locality; Belmont shaft; Bed 7, G.S.V. Fc 20, 60 feet up section, Amphitheatre, Leigh River. **GELLIBRAND CLAY:** Cutting, Cobden — Lavers Hill Rd., 0.8 miles S. of Kennedys Creek, Grid Ref. Princetown 155390; Chapple's locality, landslips on Latrobe Creek,  $\frac{3}{4}$  mile NW. of Princetown; Cutting on Princetown-Simpson Rd., 1.7 miles S. of Melrose Rd., Grid Ref. Princetown 033346; Cutting on Bornung Road at top of hill, 1.3 miles N. of Coriemungle Rd., Grid Ref. Princetown 982485. **MYARING BEDS:** Limestone Creek, Glenelg River. **CADELL MARL LENS:** Left bank, Murray River at gully 3.0 miles S. of Morgan — Cadell Rd., Grid Ref. Renmark (1:250,000) 268789, South Australia.

(Longfordian). **FISHING POINT MARL:** Cliff about 100 feet above Lake Craven, quarter mile NW. of Red Hill, Horden Vale, Grid Ref. Aire 359149; 20-30 ft. above Lake Craven SE. side Fischers Point, Horden Vale, Grid Ref. Aire 359158; Slips on S. side of Lake Costin, 0.3 miles W. of Horden Vale - Red Hill Rd., Horden Vale, Grid Ref. Aire 363163.

**MATERIAL:** Types and fifteen topotypes.

**COMMENTS:** The broad fusiform shape, spinose axial costae and strongly developed spiral sculpture distinguish this subspecies. It has evolved from the Puebla Clay *A. (T.) anticingulata craticula* by the development of shoulder spines on the costae and by widening of the shoulder. The specimen chosen as lectotype is the larger and better preserved of the three syntypes.

*Athleta (Ternivoluta) antiscalaris levior* (McCoy, 1866)

Pl. 15, fig. 15-16; Pl. 16, fig. 35-36.

*Voluta antiscalaris levior.* McCoy 1866, Ann. Mag. Nat. Hist. ser. 3, 18 (107) : 379.

McCoy 1874, Prod. Pal. Vict. 1: 28.

*Volutiithes antiscalaris.* Harris 1897, Catalogue of Tertiary Mollusca, p. 97, pl. 4, fig. 8a-b.

Cossmann 1899, Essais de Paléoconchologie Comparée 3, pl. 5, fig. 4.

**DESCRIPTION:** Shell fusiform with a gradate spire and slenderly tapering body whorl. Protoconch and early whorls as in *A. (T.) antiscalaris* s.s. Sutural groove widening rapidly to form a prominent shoulder on the body whorl. Sutural nodules spinose, prominent and separated from the suture by a narrow channel so that the shoulder is double stepped. Axial costae, short, prominent, spinose on the shoulder extending anteriorly over about a quarter of the body whorl, 14 - 16 on the body whorl. Spiral lirae absent from the spire whorls, feebly developed immediately anterior to the shoulder or in some cases confined to the anterior third of

---

PLATE 16.

Fig. 24, 26. *A. (T.) studeri* (Martens), 22678, holotype, off Cape Moreton, Qld.

Fig. 25. *A. (T.) antiscalaris* (McCoy), P12163, paralectotype, Curlewis, Vict.

Fig. 27, 32. *A. (Athleta) wangerrip* sp. nov., P22474, paratype, Aw7, Rivernook, Vict., X 1 $\frac{1}{2}$ .

Fig. 28, 31. *Ibid.*, P28032, holotype, Aw7, Rivernook, Vict., X 1 $\frac{1}{2}$ .

Fig. 29. *A. (Ternivoluta) antiscalaris antispinosa* (Tate), T1449, holotype, "Murray Desert."

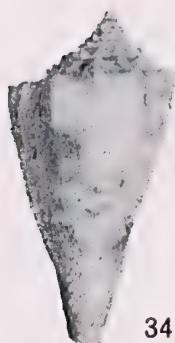
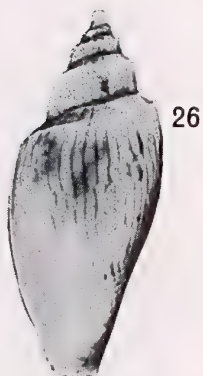
Fig. 30, 33. *A. (T.) bungae* sp. nov., P22485, holotype, Bunga Creek Cutting, Vict.

Fig. 34. *A. (T.) antiscalaris antispinosa* (Tate), P22487, hypotype, Lake Bullenmerri, Vict.

Fig. 35, 36. *A. (T.) antiscalaris levior* (McCoy), P12165, paralectotype, Fossil Beach, Mornington?, Vict.

Fig. 37. *A. (T.) antiscalaris antispinosa* (Tate), P22488, hypotype, Wiridgil, Camperdown, Vict.





the body whorl. Columella with three or four major and two or three minor plaits.

*DIMENSIONS:*

Lectotype	P12166	L48	HA36	W23	
Paralectotype	P12165	51	39	23	
Paralectotype	P12167			21	Specimen broken.
Paralectotype	P12168	10			Juvenile.

*LOCATION OF TYPES:* National Museum of Victoria, Lectotype P12166, Paralectotypes P12165, P12167, P12168 collected W. Kershaw prior to 1864.

*TYPE LOCALITY:* Mount Martha, i.e. Fossil Beach, Balcombe Bay, 1½ miles S. of Mornington. Grid. Ref. Cranbourne 072845. Balcombe Clay, Balcombian, Middle Miocene.

*STRATIGRAPHIC RANGE:* Balcombian — Bairnsdalian, Middle Miocene.

*OCCURRENCE:* BALCOMBE CLAY (Balcombian): Type locality; 200 yds. S. of Gunyoung (= Grices) Creek; Kackeroboite (= Dennant) Creek about 50 yds. from the older volcanics, Grid Ref. Cranbourne 120928. (Bairnsdalian): Cliff section to the S. of Manyung Rocks and N. of sewer pipe and jetty, bed 10Ba, Grid Ref. Cranbourne 106903; Downstream section Grices Creek, beds 8 Ba-g, Grid Ref. Cranbourne 111910. NEWPORT FORMATION (Balcombian): Southeastern Trunk Sewer between Braeside shaft and shaft at corner of Boundary and Centre Dandenong Rds., Dingley. (Horizon not known): Altona Bay Coal Shaft. FYANSFORD CLAY (Balcombian): Red Hill, Shelford-Inverleigh Rd., Grid Ref. Beac 064066; Left bank, Native Hut Creek, SW. of Glenleigh, Grid Ref. Geelong 173034. (Bairnsdalian): Right Bank, Native Hut Creek, 100 yds. S. of Hamilton Highway, Grid Ref. Geelong 181009; Junction of Native Hut Creek and Barwon River, Grid Ref. Geelong 184003; Left bank, Barwon River, section 2B, Parish of Murgheboluc, Grid Ref. Geelong 197988; Left bank, Barwon River near junction with Bruces Creek, section 4A, Parish of Murgheboluc, Grid Ref. Geelong 229982. GELLIBRAND CLAY (Bairnsdalian): Cliff at NW. end of Gibson Beach, Princetown, Grid Ref. Princetown 022298; Clay immediately beneath limestone on track to V.A.L. quarry, Curdies, Grid Ref. Panmure 871589; Cutting Timboon-Port Campbell Rd., 100 yds. S. of Timboon shops, Grid Ref. Panmure 892534. MUDDY CREEK FORMATION (Balcombian): Clifton Bank, Muddy Creek, Hamilton. (Bairnsdalian): Grange Burn, ¾ mile above Henty's House, Hamilton.

*MATERIAL:* Types and twenty topotypes.

*COMMENTS:* This subspecies is distinguished from *A. (T.) antiscalearis* generally by its less tumid body whorl, more prominent shoulder spines, shorter and bolder axial costae and by the decrease in prominence of the spiral lirae. However as some specimens of *A. (T.) antiscalearis* s.s. are somewhat similar in morphology to the stratigraphically older specimens of *A. (T.) antiscalearis levior*, it is felt that subspecific rather than specific separation is warranted. Similarly stratigraphically younger specimens of *A. (T.) antiscalearis levior* show affinity with *A. (T.) antiscalearis antispinosus* (Tate).

## Athletinae

The specimen chosen as lectotype is a typical representative of the Fossil Beach population but the paralectotype P12165 is closely akin to those found at Grices Creek (= Mt. Eliza) and is probably incorrectly located.

*Athleta (Ternivoluta) antiscalaris antispinosa* (Tate, 1899)

Pl. 16, fig. 29, 34, 37

*Volutilithes antispinosus*. Tate 1899, *Trans. R. Soc. S. Aust.* 23 (1): 107, pl. 1, fig. 5a, b.*Austrovoluta antispinosa*. Cotton 1949, *Rec. S. Aust. Mus.* 9 (2): pl. 15.

**DESCRIPTION:** Shell pyriform with a short squat subconical spire and tumid bodywhorl, abruptly tapering to the anterior canal. Sutural groove of early spire whorls widening rapidly and forming a prominent shoulder on the body whorl. Sutural nodules spinose when present but much reduced and absent in stratigraphically younger specimens. Anterior whorl slope of spire completely covered by succeeding whorl. Axial costae spinose on the shoulder, broad and short extending anteriorly over one quarter to one third of the body whorl (eleven or so present on the body whorl). Spiral lirae developed only on the anterior portion of the body whorl and the anterior canal. Columella with three or four major and two or three minor plaits.

**DIMENSIONS:**

Holotype T1449	L47	HA—	W24	
Hypotype P22487	47	38	22	NW. corner Lake Bullenmerri.
Hypotype P22488	47	35	23	Wiridgil.

**LOCATION OF TYPES:** Tate Museum, Geology Department, Adelaide University, Holotype T1449. National Museum of Victoria, Hypotype P22487; coll. E. D. Gill, 5 June 1957; Hypotype P22488, coll. W. A. H., T. S. Hall in F. A. Cudmore collection.

**TYPE LOCALITY:** Well sinking, Murray Desert. Tate (1899) states that his Murray Desert material comes from two wells, one at Mindarie, South Australia and the other at Tareena, New South Wales. From comments in the paper and because at least three other species described or recorded in the paper come from Mindarie it seems probable that this is the type locality.? Bookpurnong Beds, Cheltenhamian, Upper Miocene.

**STRATIGRAPHIC RANGE:** Bairnsdalian, Middle Miocene — Cheltenhamian, Upper Miocene.

**OCCURRENCE:** ? BOOKPURNONG BEDS (Cheltenhamian): Type locality. RUTLEDGES CREEK MEMBER, Port Campbell Limestone (Bairnsdalian): G. S. V. Aw10, cliff at Rutledge Beach, Grid Ref. Princetown 954345. BULLENMERRI CLAY (Bairnsdalian): NW. shore of Lake Bullenmerri, Camperdown; Well at Wiridgil, Camperdown. GOODWOOD FORMATION (Cheltenhamian) Bed of Spring Creek, half mile NE. of Spring Creek Homestead, Minhamite, Grid Ref. Hawkesdale 367129. ROSE HILL MARL MEMBER, Tambo River Formation (Mitchellian): Rose Hill near Bairnsdale. JEMMYS POINT FORMATION (Cheltenhamian): Sample 1, 66 - 120 feet, Bore 12, Parish of Stradbroke, Grid Ref. Stradbroke 966777.

**COMMENTS:** This subspecies is characterised by the very low spire. Some stratigraphically older specimens such as those from Lake Bullenmerri match the type specimen closely in overall morphology but as other specimens approach *A. (T.) antiscalaris levior* in shape and also have a row of subspinose sutural nodules, showing that they are derived from that subspecies, it seems preferable to regard this taxon as a subspecies of *A. (T.) antiscalaris*.

*Athleta (Ternivoluta) bungae* sp. nov.

Pl. 16, fig. 30, 33.

**DESCRIPTION:** Shell pyriform with a squat conical spire. Protoconch as in *A. (T.) antiscalaris*. Posterior whorl slope without sutural groove except on the first one or two juvenile whorls so that the posterior whorl slope of the spire whorls is flat and the spire conical rather than gradate. Axial costae numerous (about 25 on the body whorl), thin, extending from the posterior suture over half the body whorl, and raised into slight nodes where they are crossed by the spiral lirae of the posterior whorl slope. Spiral lirae present over the whole of the anterior whorl slope of the body whorl. Columella with four major and three or more minor plaits.

**DIMENSIONS:**

Holotype	P22485	L48	HA38	W21
----------	--------	-----	------	-----

**LOCATION OF TYPE:** National Museum of Victoria. Holotype P22485, F. A. Cudmore Collection, collected 1936 or 1939.

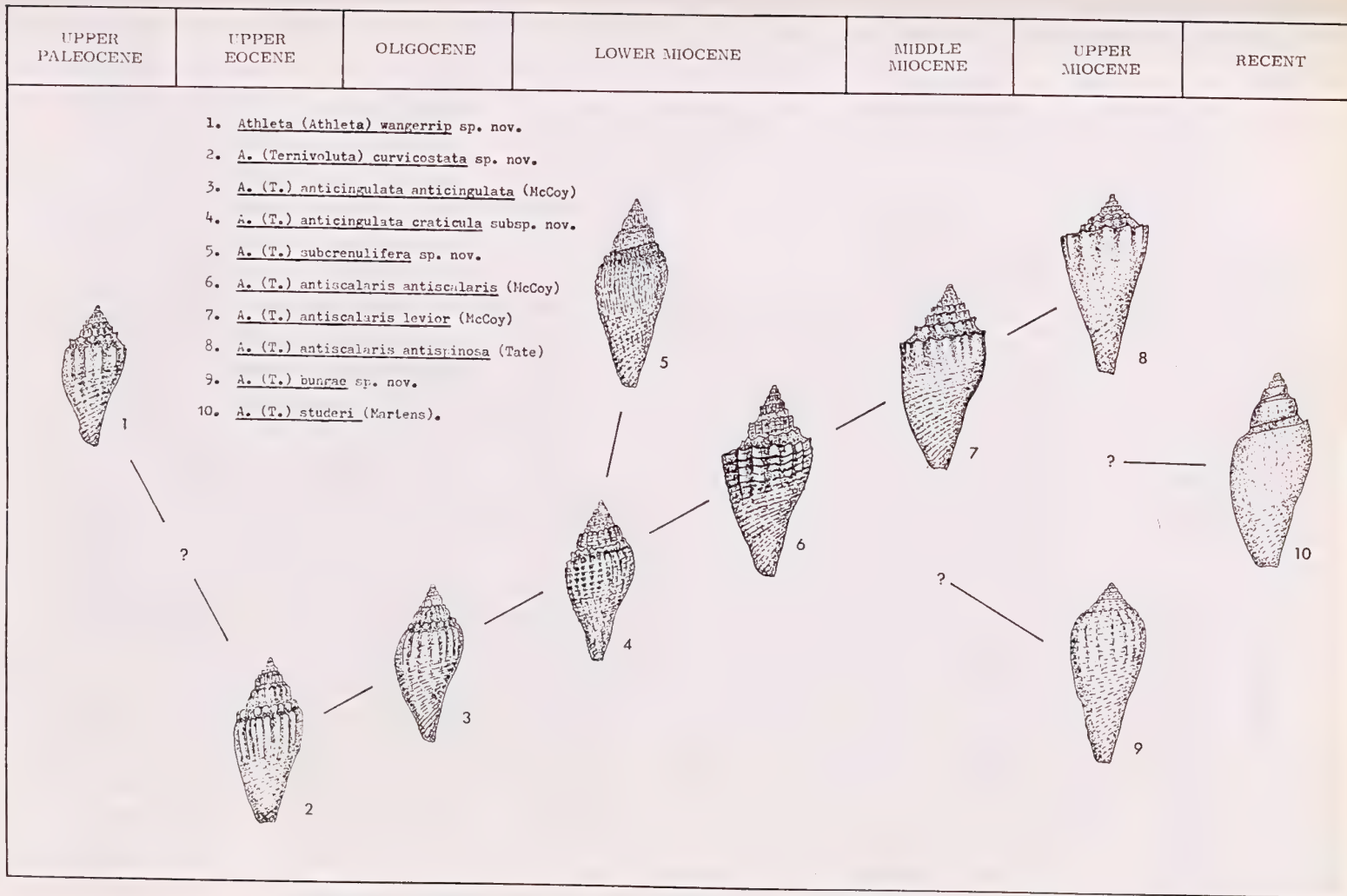
**TYPE LOCALITY:** Cutting on Princes Highway, left bank, Bunga Creek, Lakes Entrance, Grid Ref. Hartland 961302. Up until the widening of the cutting in 1961 the only shell bed outcropping was bed (b) of Wilkins (1963). The collections of mollusca associated with the type are all typical of this bed rather than the younger shell beds exposed near the top of the cutting. Jemmys Point Formation, Cheltenhamian, Upper Miocene.

**STRATIGRAPHIC RANGE:** Cheltenhamian, Upper Miocene.

**OCCURRENCE:** JEMMYS POINT FORMATION (Cheltenhamian): Type locality; Ritchies Cutting, Scrivenors Rd., right bank, Mississippi Creek, G. S. V. loc. Fl., Grid. Ref. Bairnsdale 878329; Lake Bunga Crossing; Lowest shell bed in cutting on Nyerimalang Rd. about 12 feet above and on the left bank of Meringa Creek, Grid Ref. Bairnsdale 866283; Bluff on W. side of North Arm, S. of Hunter Gully, Lakes Entrance, Grid Ref. Bairnsdale 909276; just below high tide level on E. side of North Arm on Point at end of Ferndale Parade, Lakes Entrance, Grid Ref. Bairnsdale 913276.

**MATERIAL:** Type specimen, five fragmentary topotypes and several other fragmentary specimens.

**COMMENTS:** The species is distinguished by the lack of spines, the conical spire and hence lack of a shoulder and by the fine cancellate appearance of the sculpture. It is not possible to directly derive this species from any other presently known. The only other species known from Gippsland, *A. (T.) antiscalaris antispinosa* (Tate) does not appear to have any obvious connection with it.



Schematic representation of the evolution of *Ternivoluta* in Australia.

*Athleta (Ternivoluta) studeri* (Martens, 1897)

Pl. 16, fig. 24, 26; Fig. C.

*Voluta (Psephaea) concinna*. Schacko 1881, *Conchologische Mittheilungen*. 2 (1 & 2): 126, pl. 24, fig. 5, (radula), (non Broderip 1836).

*Voluta (Ternivoluta) studeri*. Martens 1897, *Arch. Naturgesch.* 63 (1): 177, pl. 17, fig. 2.

*Ternivoluta studeri*. McMichael 1959, *Proc. R. Zool. Soc. N.S.W.* for 1957-58: 60, fig. 1.

McMichael 1960, *J. Malac. Soc. Aust.* 4: 4, Text fig. 1A (radula).

*Volutocorbis (Ternivoluta) studeri*. Shikama & Horikoshi 1963, *Selected shells of the World*. 1: 97, pl. 79, fig. 1.

*Ternivoluta studeri*. Weaver & du Pont 1970, *Living Volutes*, p. 13, pl. 3A, 3B; fig. 3.

**DESCRIPTION:** Shell elongately fusiform with a high gradate spire and rounded body whorl tapering gently to the anterior canal. Sutural groove narrow but forming a prominent shoulder on the adult whorls. No sutural nodules. Thin axial costae present only on the first whorl, absent from the succeeding whorls. Shoulder nodules developed on the costae and persisting to the adult whorls but irregularly developed and much reduced in size. Spiral lirae weakly developed and confined to the anterior portion of the body whorl. Four major and three or four minor plaits. Colour pattern of thin axial chestnut bands and three interrupted thicker spiral bands on the body whorl, one of which is also present on the spire.

**DIMENSIONS:**

Holotype	26678	L50	HA35	W22
----------	-------	-----	------	-----

**LOCATION OF TYPES:** Zoologisches Museum, Museum für Naturkunde der Humboldt-Universität zu Berlin. Holotype. 26678.

**TYPE LOCALITY:** "Gazelle" station 40, Lat. 26° 51.1' S, Long. 153° 29.6' E, 76 fathoms (139 metres), 12 miles N. by NNW. from Cape Moreton, Queensland. 27 Sept. 1879.

**OCCURRENCE:** QUEENSLAND: 60 - 100 fathoms off Cape Moreton; 15 fathoms, Tin Can Bay (Wide Bay); South of Double Pt. Is.; NEW SOUTH WALES: 68 fathoms NNE. of Cape Byron.

**MATERIAL:** Numerous topotypes.

**COMMENTS:** This species is distinguished from the others in the genus by the overall smoothness of the whorls. McMichael (1960) has commented on the similarity of the radula and gross anatomy to that of *Athleta (A.) abyssicola* (Adams & Reeve). Detailed anatomical studies are currently being undertaken by Dr. W. F. Ponder of the Australian Museum. Of the species in the Victorian Tertiary, *A. (T.) studeri* is closest to the Bairnsdalian *A. (T.) antiscalaris levior* (McCoy).

**ACKNOWLEDGEMENTS**

The author wishes to thank Mr. K. Bell for reading the manuscript and Mrs. Nancie Wortley for typing it. Several persons contributed specimens or photographs and the author expresses his thanks to Mr. J. Berric of Hawthorn, Dr. A. Beu, New Zealand Geological Survey; Dr. R. Kilius and Dr. H. Jaeger, Museum für Naturkunde, Berlin; Mr. F. Guy, Royal Melbourne Institute of Technology; Dr. T. Waller, United States National Museum; Dr. M. Shastry, Geological Survey of India; Professor M. Glaessner and Dr. Mary Wade, University of Adelaide.

## Athletinae

## ACKNOWLEDGEMENTS FOR PHOTOGRAPHS

Fig. 1 - 23, 25, 27 - 28, 30 - 37 are from photographs by Mr. Frank Guy. Fig. 24, 26 are from Museum für Naturkunde, Berlin photographs. Fig 29 is from a Geology Department, University of Adelaide photograph. All figures natural size unless stated otherwise.

## REFERENCES

- CONRAD, T. A., 1853. Synopsis of the genera *Cassidula*, Humph., and of a proposed new genus *Athleta*. *Proc. Acad. Nat. Sci. Philad.* 6 (12): 448-9.
- COSSMANN, M., 1899. *Essais de paléoconchologie comparée*. 13. Author, Paris. 201 pp., 8 pls.
- 1906. *Paléoconchologie. Revue crit. Paléozool.* 10 (4): 215-227
- 1909. *Essais de paléoconchologie comparée*. 8. Author, Paris 248 pp., 3 pls.
- COTTON, B. C., 1949. Australian Recent and Tertiary mollusca. Family Volutidae. *Rec. S. Aust. Mus.* 9 (2): 181-196, pl. 13-16.
- DALL, W. H., 1890. Contributions to the Tertiary fauna of Florida. Part 1. *Trans. Wagner free Inst. Sci. Philad.* 3 (1): 1-200, pl. 1-12.
- FISCHER, W. L., P. U. RODDA, and J. W. DIETRICH, 1964. Evolution of *Athleta petrosa* stock (Eocene Gastropoda) of Texas. *Publ. Univ. Tex. Bur. econ. Geol.* 6413.
- HARRIS, G. F., 1897. *Catalogue of Tertiary mollusca in the Department of Geology, British Museum (Natural History). Part 1. The Australasian Tertiary Mollusca.* British Museum (Nat. Hist.), London. 407 pp., 8 pls.
- JOHNSTON, R. M., 1888. *Systematic account of the geology of Tasmania.* Govt. Printer, Hobart. 408 pp., 57 pls.
- LUDBROOK, N. H., 1961. Stratigraphy of the Murray basin in South Australia. *Bull. geol. Surv. S. Aust.* 36.
- in Parkin, L. W., 1969. *Handbook of South Australian Geology.* Geological Survey of South Australia, Adelaide. 268 pp.
- von MARTENS, E., 1897. Conchologische Miscellen II. *Arch. Naturgesch.* 63 (1) (2): 157-180, pl. 15-17.
- MCCOY, F., 1866. On some new species of fossil volutes from the Tertiary beds near Melbourne. *Ann. Mag. Nat. Hist. ser. 3*, 18 (107): 375-531.
- 1874. *Prodromus of the Palaeontology of Victoria.* Decade 1. Geological Survey of Victoria, Melbourne. 43 pp., 10 pls.
- McMICHAEL, D. F., 1959. The rediscovery of *Ternivoluta studei* Martens (Mollusca: Volutidae). *Proc. R. Zool. Soc. N.S.W.* for 1957-58: 60-62.
- 1960. Notes on some Australian Volutidae. *J. Malac. Soc. Aust.* 4: 4-13.
- PRITCHARD, G. B., 1896. A revision of the fossil fauna of the Table Cape beds, Tasmania, with descriptions of new species. *Proc. R. Soc. Vict.* 8: 74-150, pl. 2-4.
- 1913. A revision of the fossil volutes of the Table Cape beds, Tasmania, with descriptions of new species and varieties. *Ibid.* 26: 192-201, pl. 20-21.
- REHDER, H. A., 1969. *Volutocorbis* and *Fusivoluta*, two genera of deepwater Volutidae from South Africa. *Veliger* 11 (3): 200-209, pl. 40-43.
- SCHACKO, G., 1881. *Radula-Untersuchungen.* *Conchologische Mitth.* 2 (1 + 2): 122-127, pl. 24.
- SHIKAMA, T. and M. HORIKOSHI, 1963. *Selected shells of the World illustrated in colours.* 1.
- SMITH, B., 1906. Phylogeny of the races of *Volutilithes petrosus*. *Proc. Acad. Nat. Sci. Philad.* 58 (1): 52-76, pl. 2.
- SMITH, M., 1942. *A review of the Volutidae.* Beal-Maltbie Shell Museum, Lantana, Florida. 127 pp., 26 pls.
- SYKES, E. R., E. A. SMITH and G. G. CRICK, 1898. Mollusca. *Zool. Rec.* 34 (7): 1-78.
- TATE, R., 1889. The gastropods of the Older Tertiary of Australia — Part II. *Trans. R. Soc. S. Aust.* 11: 116-174, pl. 2-10.
- 1899. On some Older Tertiary fossils of uncertain age from the Murray Desert. *Ibid.* 23 (1): 102-111, pl. 1.
- THEILE, J., 1929. *Handbuch der systematischen Weichtierkunde.* 1 (1) Fischer, Jena. 376 pp.
- VREDENBURG, E. 1925. Description of mollusca from the post-Eocene Tertiary formation of North-western India: Cephhalopoda, Opisthobranchiata, Siphonostomata. *Mem. Geol. Surv. India.* 50 (1): 1-350, pl. 1-13.
- WEAVER, G. S. and J. E. du PONT, 1970. *Living Volutes. A monograph of the Recent Volutidae of the World.* Delaware Museum of Natural History, Greenville, Delaware. 375 pp., 79 pls.
- WENZ, W., 1943 (1938-44). *Handbuch der Paläozoologie* 6 (1) Gastropoda (1 - 7). Gebrüder Borntraeger, Berlin. 2 vols.
- WILKINS, R. W., 1963. Relationships between the Mitchellian, Cheltenhamian and Kalimnan stages in the Australian Tertiary. *Proc. R. Soc. Vict.* 76: 39-59.